DISCRETE-TRIAL TRAINING FOR AUTISTIC CHILDREN WHEN REWARD IS DELAYED: A COMPARISON OF CONDITIONED CUE VALUE AND RESPONSE MARKING

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Three children with autism were taught to identify pictures of objects. Their speed of acquisition of receptive speech skills was compared across two conditions. In the cue-value condition, a compound audiovisual stimulus was presented after correct responses and again when a primary reinforcer was delivered after a 5-s delay; in the response-marking condition, a second stimulus was presented after both correct and incorrect responses, but not prior to the primary reinforcer. In both conditions primary reinforcement was delayed for 5 s. Although the children learned receptive speech skills in both conditions, acquisition was faster in the cue-value condition.

DESCRIPTORS: conditioned reinforcement, cue value, response marking, discrete-trial training, children with autism

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A major treatment goal of early intervention for children with autism is to establish conditioned reinforcers (e.g., praise) that can motivate performance in discrete-trial training. Early animal research showed that conditioned reinforcement functions result from classical conditioning (i.e., an initially neutral cue acquires value because of its association with primary reinforcement). This *cue-value* interpretation has been supported by research using children with autism (Lovaas et al., 1966) and is routinely used in discrete-trial training (Lovaas et al., 1981).

A different approach to improving performance in discrete-trial training might be to draw a child's attention to every response, whether correct or incorrect. This idea, *response marking*, has been shown to support accurate discrimination performance in rats, even when primary reinforcement is delayed (Lieberman, McIntosh, & Thomas, 1979). The critical difference between cue-value and response-marking procedures is that, in the former, a cue follows only the to-be-reinforced responses, whereas in the latter, the same cue follows both correct and incorrect responses; any marking effect is therefore independent of cue value. Williams (1994), also using rats, showed that, although cue value was superior to marking, both procedures supported learning when primary reinforcement was delayed.

Response marking may be an effective way to facilitate learning in applied settings. It may, for example, increase the likelihood that, during a long series of discrete trials, children will continue to attend to the act of choosing. Marking may generate a self-directed observing response that, by drawing attention to behavior just emitted, facilitates acquisition of the relation between correct responses and later reinforcement. The aim of this study was to compare cue-value and response-marking procedures (Williams, 1994) using a discrete-trial receptive labeling

procedure with delayed reinforcement and children with autism as participants.

METHOD

Participants and Setting

Andrew, Claire, and Steven, 3 children with autism (4, 5, and 8 years old, respectively), participated. All attended an ABA school and had thus previously received intervention based on discrete-trial training. All could understand and comply with simple requests in discrete-trial procedures, including pointing to some familiar objects when they were named (receptive labeling). Videorecorded experimental sessions were conducted in a corner of the classroom where participants received daily instruction.

Materials

A receptive labeling pretest identified as targets for training 12 card-mounted photographs of toys that were not identified accurately on four trials. Each photograph was 12 cm by 10 cm and was taken against the same background and from the same angle.

Two 1-s response-contingent compound audiovisual stimuli (green light/buzzer, and red light/high-pitched tone), generated by two visually discriminable table-mounted displays, could be delivered using a foot pedal. Two pretests ensured that neither compound stimulus had sensory reinforcing properties. In each pretest, participants were offered two similar toys (e.g., a red and a blue car) and, when the child chose one, the test stimulus was delivered. A clear preference for the toy associated with the stimulus indicated a sensory reinforcement effect. None of the children showed such a preference.

Design

An alternating treatments design allowed the effects of training receptive labels to be compared across cue-value and response-marking conditions. Each child participated in a daily morning and afternoon training session, each lasting 15 min and separated by a 4-hr interval, with treatments counterbalanced to control for order effects. A multiple probe design was also used in each condition. A block of probe trials (i.e., four trials each of both trained and to-be-trained labels) was conducted before teaching began and after each label had reached criterion.

Procedure

Training trials for each receptive label were initiated by the teacher saying, "Touch [pictured object]" and manually prompting the child to select the correct card (i.e., the S+) from an array of three. Positions of S+ and incorrect comparison (S−) cards were randomized between trials. Only unprompted correct responses were reinforced with a preferred food; prompted responses were reinforced with praise. A 5-s reinforcement delay was used for both prompted and unprompted responses. Prompts were withdrawn as soon as possible. The mastery criterion for the first and all subsequently trained labels was 10 consecutive unprompted correct responses. To-be-learned labels were interspersed with previously mastered items in a 2:1 ratio. The response-contingent stimulus procedure differed between conditions. In the cue-value condition, the 1-s compound red light/tone stimulus was presented twice following each correct response, once immediately and once after the 5-s delay (i.e., contiguously with food reinforcement). In the response-marking condition, the 1-s compound green light/buzzer stimulus was presented immediately after both correct and incorrect responses but not after the 5-s delay (i.e., not contiguously with food reinforcement on correct trials). In both conditions, incorrect trials were repeated. To assess maintenance for each child after 1 month, an eight-trial posttest was

conducted for each label spread across two separate sessions.

Reliability. A second observer scored 25% of videotaped sessions for response reliability (agreement that a response was correct or incorrect) and consequence reliability (agreement that response-contingent stimuli were delivered appropriately). Reliability (agreements divided by agreements plus disagreements and multiplied by 100%) was 100% for responses and 95% (range, 91% to 100%) for consequences.

RESULTS AND DISCUSSION

The analysis revealed an advantage for the cue-value condition. Figure 1 shows that all 3 children acquired the first three receptive labels trained in the cue-value condition faster than in the response-marking condition. The total number of trials to criterion in the cue-value and response-marking conditions, respectively, were: Andrew, 72 and 314; Steven, 109 and 253; and Claire, 72 and 123. Given the strength of this effect, the procedure was modified so that the last three labels assigned to the response-marking condition were taught using the cue-value procedure. Figure 1 shows that, under the revised procedure, total number of trials to criterion for 2 of the children were similar (Andrew, 118 and 101; Steven, 114 and 88; in the unchanged and revised conditions, respectively). Claire did not learn the final two labels because an illness prevented her from attending school.

Multiple-probe data for each child showed that the acquisition of labeling was a function of the training procedure used. For every label in both conditions, correct responding was at chance level before training but at 100% after training. The posttest data revealed a high level of retention of receptive labels for all participants. The percentage of correct responses at posttest was similar in the cue-value and response-mark-
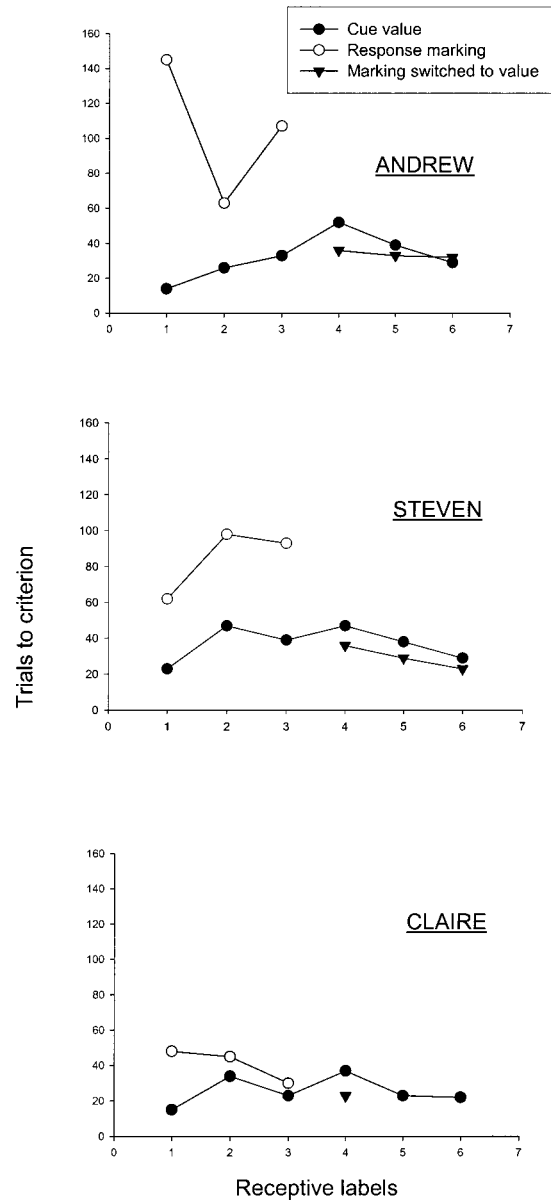

Figure 1.   Number of training trials to learn each receptive label.

ing conditions, respectively: Andrew, 88% and 83%; Steven, 77% and 88%; and Claire, 90% and 83%. Taken together, the data show that learning was faster in the cue-value condition than when response marking was used, thus extending Williams' (1994) finding from animal to human participants. Clearly, however, response marking still sup-

ported acquisition, albeit less efficiently. For Claire, in particular, the difference between conditions was modest, suggesting that refinements of the response-marking procedure might have important practical applications.

Future investigations should aim to consider more socially valid forms of value ("good!") and marking ("look!"). It would also be useful to see whether differences between the procedures would be sustained with extended delays to reinforcement. Although even small delays can disrupt discrete-trial training, bridging longer delays would be more functional for learners. Future procedural comparisons could be further refined by including an additional control condition in which no response-contingent cues are delivered at the start of the delay, which terminates in primary reinforcement.

In summary, our data support Williams' (1994) animal research showing that cue value is superior to response marking but that both procedures led to learning. We showed the same effects in children with autism in an applied setting. These data contribute to the growing body of literature on how to increase desirable responses when primary reinforcers cannot be delivered immediately (Dixon & Cummings, 2001; Neef, Bicard, & Endo, 2001).

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